Diet Analysis of the Western Grey Kangaroo (*Macropus fuliginosus*) in Wyperfeld National Park by Microscopic Faecal Analysis

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Abstract

Diet analyses were carried out by microscopic examination of faecal pellets on samples collected in the six major habitats of Wyperfeld National Park during August 1983, in order to ascertain the selective and/or preferential feeding habits of the Western Grey Kangaroo (*Macropus fuliginosus*). It was found that the majority of the diet consisted of monocotyledons, although actual percentages and species eaten changed between habitats.

Introduction

Diet analyses of herbivorous mammals, such as sheep and kangaroos, have been recorded at many different locations. For example Storr (1961), Griffiths *et al.* (1974), Ellis *et al.* (1977) used microscopic analyses of faeces, and Taylor (1983) used analysis of gut content, to ascertain the diet of herbivorous mammals. This study, based at Wyperfeld National Park (NW Victoria) in August 1983, investigated the feeding habits of the Western Grey Kangaroo (*Macropus fuliginosus*), using microscopic analyses of faeces.

Western Grey Kangaroos are found in a wide area, from south-western Australia through the south into western Victoria, where its range overlaps with the Eastern Grey Kangaroo (*M. giganteus*).

Western Greys are predominantly nocturnal or crepuscular (twilight) in habit (Russell 1974). They spend much of the middle part of the day lying under trees and shrubs in highly organised social groups (Caughley 1964). They are sedentary, rarely moving more than a few miles in search of food, even in drought conditions (Russell 1974). Their home range (i.e., the area over which they travel in pursuit of routine activities), is therefore very small in comparison with Red Kangaroos (*Megaleia rufa*) which often travel extensively (Russell 1974).

Previous studies (Low *et al.* 1981; Russell 1974; Griffiths *et al.* 1974) have shown that kangaroos much prefer grasses to other feed; Eastern Greys often eat approximately 89% grass in their diet.

Kangaroos have a higher proportion of monocotyledons in their diet than dicotyledons, although monocotyledons have a lower nitrogen content (Brown and Main 1967; Griffiths *et al.* 1974; Taylor 1980). Griffiths *et al.* (1974) suggest that kangaroos are capable of using the soluble carbohydrates present in grasses as their energy source, thereby avoiding the need to deaminate proteins for this purpose, and so retaining more nitrogen.

Morgan (1986) has classified Wyperfeld National Park into the following six habitats: Lakebeds; *Callitris* Woodlands; River Red Gum Woodlands (*Eucalyptus camaldulensis*); Black Box Woodlands (*Eucalyptus largiflorens*); Mallee and Heath; and Sand-Dune Herbfields. This study used this habitat classification to investigate the distribution and diet of the Western Grey Kangaroo in Wyperfeld National Park during August 1983.

Materials and Methods

Using binoculars and rangefinders, two transects (after Morgan 1986) were covered in order to calculate the distribution and

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density of the Western Grey Kangaroo. Between them, these transects covered all six of Morgan's major habitats. A minimum of six subsamples of fresh and old kangaroo pellets were gathered from each habitat. Plant specimens were collected from each habitat; some were pressed for later identification using the Wyperfeld herbarium based at the Botany Department of Monash University, while others were stored as fresh samples at 4°C for later analysis.

Cuticular Preparations

Fresh material from selected, identified plant specimens was cut into small pieces and cleared, usually overnight, in 4% sodium hypochlorite solution. The cuticles were then rinsed well to remove bleach and stained in crystal violet or gentian violet for approximately 30 seconds and mounted in Karo syrup on microscope slides (R. Waters, Zoology Department, Monash University, *pers. comm.*; Ellis *et al.* 1977). Both adaxial and abaxial surface preparations were made and distinguishing features were photographed for reference at x100, x400 and x600.

Faecal Preparations

The six or more subsamples collected from each habitat were pooled, and one faecal analysis per habitat was carried out, using the following method. Kangaroo pellets were soaked in warm water, ground, using a pestle and mortar, and then cleared in 4% sodium hypochlorite for an average of 2-4 hours at 50°C, or for longer times (up to several days) if necessary. The residue was rinsed thoroughly with water, stained and mounted as for the cuticular preparations. These slides were then scanned under x100 magnification using a 500 μm x 500 μm grid. Epidermal segments, lying over grid intersection points, were classified and recorded using epidermal cell shape, hairs and silica bodies as identification aids. Where possible classification was made at the species level but mostly only broad distinctions between the narrow elongated cells of monocotyledons and the tabular irregularly-shaped cells of dicotyledons were made (Esau 1977; Ellis *et al.* 1977).

Results

a) Transects

The distribution and densities of the Western Grey Kangaroo during August 1983 were greatest in the two most exposed habitats, i.e., Sand-Dune Herbfields and Lakebeds (Table 1). Morgan, (1986) using a similar method over several years in this same area, showed that this is not a constant situation. His data for 1981 are reproduced also in Table 1.

b) Species Lists

Species lists from each habitat except the Mallee and Heath habitat are included in Table 2

c) Cuticle Reference Preparations

Plant species found in faecal pellets collected from the different habitats and the proportions of monocotyledons and dicotyledons are summarised in Table 3. Various pellet samples showed some cuticle fragments which appeared to be different from any of the reference cuticles e.g. *Callitris* Woodland pellets contained

Table 1. The distribution and densities of the Western Grey Kangaroo (*Macropus fuliginosus*) in six habitats of Wyperfeld National Park (after Morgan 1986) in 1981 & 1983.

Habitat	D. G. Morgan 1981 Individuals/hectare	August 1983 Individuals/hectare
Sand-Dune Herbfields	0.4 ± 0.1	0.4 ± 0.2
Lakebeds	0.7 ± 0.2	0.3 ± 0.1
River Red Gum Woodlands	0.9 ± 0.2	0.3 ± 0.1
Black Box Woodlands	0.7 ± 0.2	0.3 ± 0.1
Callitris Woodlands	0.8 ± 0.4	0.1 ± 0.1
Mallee and Heath	0.07 ± 0.04	0.02 ± 0.02

Table 2. The plant species recorded in each habitat. No list was available for Mallee-heath. P = species present. D = species locally dominant. Di = Dicotyledon M = Monocotyledon

Species		*Callitris* Woodlands	Sand-Dune Herbfields	Black Box Woodlands	River Red Gum Woodlands	Lakebeds
Acacia spp.	(Di)	P				
Actinobole uliginosum	(Di)	P	P	P	P	
Ajuga australis	(Di)		P			
Anagallis arvensis	(Di)	P				
Arctotheca calendula	(Di)	P	P			
Brachycome cardiocarpa	(Di)	P				
Brachycome perpusilla	(Di)					P
Brassica tournefortii	(Di)	D	D	D	D	P
Bromus diandrus	(M)	P				
Bromus rubens	(M)	D	P	P		P
Calandrinia eremaea	(Di)	P		P		
Callitris preissii	(M)	P				
Calotis hispidula	(Di)	P				
Capsella bursa-pastoris	(Di)				P	
Carex bichenoviana	(M)				P	
Centaurea melitensis	(Di)					P
Cynoglossum spp.	(Di)	P				
Danthonia spp.	(M)	P		P		
Daucus glochidiatus	(M)	D	P	D	P	P
Enchylaena tomentosa	(Di)			P		
Erodium cicutarium	(Di)	P		P		P
Erodium crinitum	(Di)	P			P	
Eucalyptus incrassata	(Di)	P				
Gnaphalium involucratum	(Di)				P	
Haloragis heterophylla	(Di)	P				
Harmsiodoxa blennodioides	(Di)	P		P		
Helipterum pygmaeum	(Di)	P			P	
Hibbertia virgata	(Di)	P				
Hordeum leporinum	(M)	P	P	D	D	D
Hypochaeris glabra	(Di)	D	P	P	P	P
Isoetopsis graminifolia	(Di)	P		P		
Leptospermum coriuceum	(Di)	P				
Marrubium vulgare	(Di)			P		D
Medicago polymorpha	(Di)		P	D	D	D
Millotia macrocarpa	(Di)	P				
Myriocephalus stuartii	(Di)	P	P	P		
Onopordum acaulon	(Di)		P	P		
Pelargonium australe	(Di)					P
Pentaschistis airoides	(M)	P	P	P		
Plantago varia	(Di)	P		P	P	
Podolepis capillaris	(Di)	P				
Schismus barbatus	(M)	P		P	P	
Senecio glossanthus	(Di)	P		P		
Senecio lautus	(Di)					P
Senecio vulgaris	(Di)					P
Silene longicaulis	(Di)		P	P		
Sisymbrium orientale	(Di)					P
Sonchus oleraceus	(Di)	P				
Stellaria media	(Di)			P		
Stipa spp.	(M)		P		P	P
Trifolium spp.	(Di)	P	P			
Trifolium tomentosum	(Di)	P		P		
Vulpia bromoides	(M)	P	P			
Vulpia myuros	(M)	P		P		

Table 3. Summary of Results of Faeces Analysis. Confidence limits are ± 1 standard deviation. It is assumed that the observed number of either monocotyledons or dicotyledons has a binomial distribution and this variance δ^2 = npq. Strictly this assumption requires that grid points be randomly distributed, but the assumption should be approximately valid since the grid spacing is large compared with the average size of cuticle particles.

Sample No.	Habitat Type	Fresh or old dung	Number of grid points intersecting cuticle	Monocotyledons %	Dicotyledons or *Callitris* %	Notes
1	Lakebed	Fresh	136 ± 4	61 ± 4	39 ± 4	Species identified were the grasses *Bromus rubens, Stipa spp. Hordeum leporinum* and the dicotyledons *Medicago, Erodium, Daucus, Sisymbrium.*
2	Sand-Dune Herbfields	Fresh	100	92 ± 3	8 ± 4	*Vulpia* was most prominent amongst the grasses. The dicotyledons *Trifolium spp.* and *Silene longicaulis* were identified.
3	,,	,,	100	83 ± 4	17 ± 4	
4	,,	,,	100	87 ± 3	13 ± 3	
5	,,	,,	100	90 ± 3	10 ± 4	
6	*Callitris* Woodlands	Fresh	100	65 ± 4	35 ± 4	*Vulpia* was the major grass component in all samples. *Trifolium* constituted over 80% of the dicotyledons present in samples 6 and 7 but was absent from sample 8. Other species identified were *Danthonia, Schismus, Triodia, Pentaschistis, Brassica* and *Callitris.*
7	,,	,,	120	67 ± 4	33 ± 4	
8	,,	Old	100	83 ± 4	17 ± 4	In sample 8, cuticles were degraded and hard to identify.
9	Mallee & Heath	Fresh	100	92 ± 3	8 ± 3	In sample 9, *Triodia* constituted over 60% of the grass component. *Callitris* was the major non-grass component.
10	,,	Old	—	—	—	In sample 10, cuticles were badly degraded no *Triodia* was identified but *Callitris* and a sclerophyllous dicotyledon similar to *Eucalyptus* were present.
11	Black Box Woodlands	Fresh	100	85 ± 3	15 ± 3	*Vulpia* was the most dominant grass consumed. Also identified were *Hordeum, Pentaschistis,* and the dicots *Oxalis, Medicago, Trifolium* and *Brassica.*
12	,,	,,	100	90 ± 3	10 ± 3	
13	River Red Gum Woodlands	Old	100	83 ± 4	17 ± 4	Species identified were *Bromus, Hordeum, Pentaschistis, Oxalis* and *Trifolium* and *Brachycome.* Bark fibres from River Red Gums may have been present.
14	,,	Fresh	100	55 ± 4	45 ± 4	

a grass of reasonably frequent occurrence with distinctive red staining bodies between the ends of adjoining cells.

Discussion

Previous studies (Low *et al.* 1981, Morgan 1986) have found that kangaroos move to open places during drought for food, but return to sheltered woodlands when there is plentiful food. This study found differences between the habitats in the grass species consumed by Western Grey Kangaroos. *Vulpia* spp. was the predominant grass found in pellets from Sand-Dune Herbfields, *Callitris* and Black Box Woodlands, but was not recorded as part of the Lakebed flora. Similarly, *Bromus rubens* was identified in Lakebed pellets but not in *Callitris* Woodlands, although it was recorded as abundant in the latter area.

The Mallee faecal samples showed a diet consisting of a high proportion of *Triodia irritans*, even though more palatable plants grew nearby. Griffiths and Barker (1966) suggest that *Triodia irritans*, which has a higher nitrogen content than many monocotyledons, is eaten in order to supplement the water and nitrogen content of the diet of Red and Grey Kangaroos, especially during periods of drought. R. Waters (*pers. comm.*) found that Swamp Wallabies (*Wallabia bicolor*) ate bark at the end of the summer when food was scarce, but at Wyperfeld, the Western Grey Kangaroos were observed eating bark from River Red Gums during August 1983 when food was plentiful and traces of bark fibres were present in River Red Gum faecal pellets. It would be interesting to study the effect of differing seasons on the selective diet of the Western Grey Kangaroo and the varying impacts grazing animals have on such a boom or bust ecological succession environment.

The plant species identified in the pellets coincided for the most part with those growing in the habitat from which the pellet was collected. Thus, this study confirms the observations of Morgan (1986) that the Western Grey Kangaroo has a small home range, and is therefore a localised feeder.

On the basis of cuticle area, grasses constituted the major dietary component in all habitat types with values ranging from over 90% in the Sand-Dune Herbfield habitat to approximately 66% in Lakebed and *Callitris* Woodlands. This could indicate that Sand-Dune Herbfield kangaroos are consuming significantly greater proportions of grasses than in the Lakebed or *Callitris* Woodlands; or could be a sampling error, as pellets collected from one area may have come only from one animal.

There are reservations about the accuracy of the results obtained because of the limited sampling and the techniques used in the microscopic analyses of faeces. Ideally, the required diagnostic features of cuticle used in the analysis of faecal samples are as follows:

i) Cuticle must be preserved during digestion and subsequent clearing.
ii) Features should be relatively constant over the surface of the cuticle.
iii) Features should occur at high frequency so that they occur on most suitable cuticle pieces.
iv) Distinctive variations between species should be observed. Several potentially useful diagnostic features of cuticles e.g. orientation and shape of cells; trichome structures (i.e. micro and macrohairs, stellate and clothing trichomes and papillae); silica bodies; costal and intercostal zones; anticlinal cell walls and stomata have been discussed (Metcalfe 1960; Metcalfe and Chalk 1950) and were used to identify plant species in this study.

Slater and Jones (1971) found that the cuticle of different plant species, and even genera, are often extremely similar and pointed out that with time, in sodium hypochlorite, certain cuticles are destroyed, or so changed as to be unrecognisable. This was especially so in dicotyledonous plants when the silica content is lower. R.

Waters (*pers. comm.*) working on the diet of wallabies in a high rainfall area of South Gippsland, found that the time required to clear sclerophyllous particles e.g. Eucalyptus leaves, was too long for the preservation of less resistant *Trifolium* spp. Waters suggests that up to three different clearing times may be necessary for each sample in order to determine accurately the different species found in faeces, and Slater and Jones (1971) found legumes ingested by cattle and detectable in oesophageal fistulas could not be detected in the faeces. More easily identifiable species will tend to be overestimated in the diet (e.g. *Triodia irritans*), and featureless species will tend to be overlooked. Griffiths *et al.* (1974) showed that estimates comparing stomach contents and faeces were in fairly good agreement but that the sclerophyllous species tended to over estimated using faeces. This difference might be real, if lower intestinal tract digestion in fact takes place, although Dawson and Ellis (1979) showed there were consistent differences between gut and faecal estimates for some plant categories. In particular, grasses were estimated to be lower in the faeces than in the guts and plants with stellate trichomes e.g. *Senecio glossanthus* and *Pelargonium australe* were always overestimated, suggesting that the principal factor affecting the difference between gut and faecal estimates was the character of the plant itself and not the type of digestion it had undergone. However, in semi-arid environments (similar to the one of this study) Ealey and Main (1967), Stewart (1967), Field (1968), Sparks and Malachek (1968), Storr (1968), Bailey *et al.* (1971) and Griffiths *et al.* (1974) have considered faecal analysis to be reasonably reliable because of the robust nature of the sclerophyllous plants containing either silica hairs or bodies of various shapes or which are lignified. Even a relatively mushy plant like *Portulacca oleracea* grown in an arid climate is robust enough to retain identifiable characteristics for faecal analysis.

The quantitative method used (point sampling using random points or, as in this study, using a widely spaced grid) provides a means of estimating relative cuticle areas in the preparation. It was used in preference to other methods, such as presence or absence of cuticle type in a microscope field (Sparks and Malachek (1968); R. Waters *pers. comm.*) or classification of 400 particles as either monocotyledons or dicotyledons (Griffith *et al.* 1974), because it was easier to standardise between different workers. In a population study it would be best to pool data derived from single pellets from a number of different animals of different age and sex over a period of time. Pellets dropped from animals with diurnal feeding patterns should be sampled at various times throughout the day. The study of single pellets can at best give information about diet over one or two hours only, depending on gut passage rates.

Allowing for these reservations, the methods used in this study have been widely used. Taylor (1983) found large kangaroos to be almost exclusive grazers with a high proportion (78% to 98%) of low-fibre grass in the diet and a variable dicotyledon component depending on the seasonal conditions and vegetation. This study confirmed these observations and, although there were more dicotyledon species in each habitat (Table 2), higher numbers of monocotyledon species were subsequently identified in the faeces (Table 3). *Brassica* was abundant in all habitat types except possibly the Mallee, but it was not identified as a significant component of the kangaroos' diet. This is probably due to selective grazing by kangaroos, or could be due to poor preservation or poor recognition of the cuticle. Sanson (1982) shows that dental morphology of kangaroos is adapted to grass eating, their many cusps being continually replaced and allowing them to cope with the high fibre content found in some grasses which supports the view that kangaroos do graze selectively for grasses.

Conclusions

Western Grey Kangaroos (*Macropus fuliginosus*) at Wyperfeld National Park during August 1983 appeared to prefer open rather than sheltered habitats.

The results from the microscopic examination of faecal pellets must be treated with caution. However, it appears certain that Western Grey Kangaroos selectively graze monocotyledon rather than dicotyledon species. The actual species grazed differ according to habitat.

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